point are perpendicular, and one of these bisects the angle formed by the remaining two lines, the sines of the angles taken in the proper order are in the harmonic ratio. Another point illustrated was that a sheaf of four lines presents the same anharmonic ratios of their sines as does a sheaf of four lines severally perpendicular to them. Reverting to the subject of the traces of the faces of a zone on their own zone plane, it was now seen that we can discuss the subject of relations of any four planes in the zone by considering those of their normals the angles between which are measured on a great circle of the sphere. But it remains to obtain an expression that shall connect these angles with the symbols of the poles or faces of the zone. Such an expression obtained by Prof. Miller in the first case involves a relation of the simplest kind. In short, the anharmonic ratio of four planes is the ratio which we obtain directly from the determinants of the symbols for the four planes. Since, however, the symbols for a zone as obtained from the symbols of different pairs of faces of the zone may, and generally do, differ by a common factor, it is advisable to put the expression for the anharmonic ratios of four tantozonal planes under the form of a convenient symbol given them by V. von Lang, viz., for the four planes $PQRS$:—

$$\begin{bmatrix} PQ \\ QR \end{bmatrix} : \begin{bmatrix} PS \\ SR \end{bmatrix} = \frac{\sin PQ}{\sin(PR-PQ)} : \frac{\sin PS}{\sin(PR-PS)} = \frac{m}{n}$$

where the letters on the left side of the expression stand for the symbols of the planes of which the determinants are to be taken. This very important expression offers the means of determining one unknown symbol or one unknown angle among those belonging to the four planes; another result that flows from it is the necessity for the anharmonic ratios of four planes in the zone, *i.e.* the magnitudes m and n, being always rational if the planes belong to a crystal. And this is another and more general way of stating the fundamental crystallographic law, that of the rationality of indices.

Prof. Maskelyne next proceeded to discuss some of the further results deducible from this great law. Firstly, since the harmonic ratio of four planes brings those planes under the requisite condition of rationality, we can say of any zone in which two of the planes are perpendicular to each other, that for any third plane of the zone inclined on one of them at an angle ϕ, a fourth plane may also exist as a possible plane of the zone, also inclined on the first plane at the angle ϕ; and further, the professor went on to state that if we ask the question what are the conditions for three consecutive planes in a crystal zone to include the same angle ϕ, we find for answer that only in those cases is this possible where cos. ϕ is rational, and that this is only so where ϕ possesses one of the values $90°$, $60°$, $45°$, and $30°$.

After a review of the results thus far obtained, the professor entered upon the subject of symmetry, and defining the different varieties of geometrical symmetry; such as, firstly, the symmetry of a plane figure to a centre of symmetry, to one or to several lines of symmetry, or to a pivot of symmetry; and secondly, that of a solid figure to a centre of symmetry, to one or to several planes of symmetry, and to one or to several axes of symmetry: he defined certain terms which would be found useful in the discussion of the symmetry of crystals. Thus, a plane figure was *enthy-symmetrically* divided by a single line of symmetry or *ortho-symmetrically* divided by two lines of symmetry perpendicular to each other; while an axis of, for instance, hexagonal symmetry became one of di-hexagonal symmetry, where each repeated element of form is itself doubled, as by reflection, on a plane of symmetry.

In applying the principles of geometrical symmetry to crystals, it was shown that the best and simplest method was that of dealing with the distribution of their poles on the sphere of projection.

The condition requisite for a single plane of symmetry to exist upon a crystal was then shown to be that this plane should be at once a zone plane and a possible face of the crystal. On the other hand, for a crystal to be symmetrical to a centre, no particular condition was requisite, since the direction and not the requisite position of a crystal plane has been seen to be the important point regarding it, while again every plane passing through the origin may be represented by the symbol of either of its poles indifferently. Now, an axial system as previously defined involves five variable quantities; namely, the three angles between the axes:

ξ, the angle YZ
η, the angle ZX
ζ, the angle XY

and the two ratios involved in the parameters, namely, $\frac{a}{b}$ and $\frac{c}{b}$.

Hence, for a crystal to be centro-symmetrical, all these five quantities may vary from one substance to another. If, however, the crystal system be divided symmetrically by a plane, two of these axial elements are absorbed in satisfying the two requisite conditions of that plane being at once a crystal face and a zone-plane.

A crystal system that is simply centro-symmetrical presents the kind of symmetry characteristic of what is called the Anorthic system of crystallography; a crystal that obeys the principle of symmetry to a single plane belongs to the Oblique or Clinorhombic system.

(*To be continued.*)

TWO REMARKABLE STONE IMPLEMENTS FROM THE UNITED STATES

THE similarity of stone implements, both modern and prehistoric, that obtains throughout the world, has been commented upon so frequently as scarcely to need further illustration. Within a few days, however, I have found two forms of arrow and javelin points that are so unusual in their shapes, and otherwise of interest,

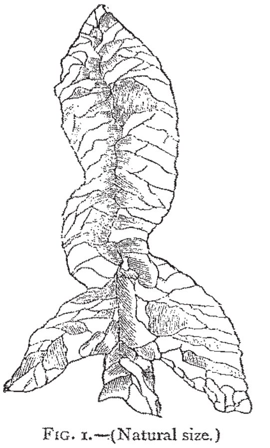

FIG. 1.—(Natural size.)

that I believe drawings of the two, and a brief note concerning them, will be welcomed by archæologists.

Fig. 1 represents a "flame-shaped" arrow-point, as this shape has been well called by Mr. E. B. Tylor (*vide* "Anahuac," by E. B. Tylor, p. 96, Fig. 1). Although I have collected fully ten thousand specimens of "Indian relics" from the immediate neighbourhood of Trenton, New Jersey, U.S.A., of which a very large proportion were spear and arrow heads, I have not been able before to duplicate this form, or to find any unmistakable trace of it in the bushels of fragments that here cover the ground in some places. This arrow-head, accompanied by the javelin (Fig. 2) and several of the leaf-shaped

pattern, was found in a fresh-water shell-heap on the bank of Watson's Creek, Mercer Co., N. J. The peculiar interest attaching to this "flame-shaped" specimen is, I consider, two-fold. First, the form is one hitherto known only as Mexican—at least, in the works on Stone Implements of which I have knowledge there is no illustration of a similar specimen; and secondly, while possibly this specimen may have been brought from Mexico, through the system of barter so extensively carried on by the aborigines—(I have found fragments of obsidian arrow-points in New Jersey, the material of which, if not the finished weapons, must have come from Mexico)—it seems more probable that it was fashioned in this neighbourhood, and being found, it may be, of an unde-

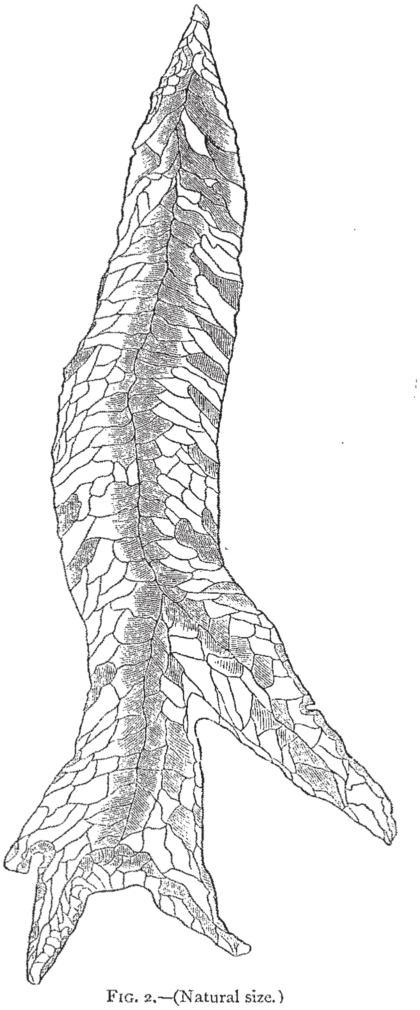

FIG. 2.—(Natural size.)

sirable shape (Mr. Tylor does not state if this pattern was common or rare in Mexico), was not adopted as one of the many forms given to this class of weapons. If my supposition is correct, then the specimen is a good example of the production of a similar style of weapons in distant quarters of the globe.

The mineral, both of this specimen and that which is represented by Fig. 2, is a dull bluish-white hornstone, very similar in general appearance to the European flint. The smaller specimen measures two and a quarter inches in length. It is noticeably thin, and remarkable for the small size and irregular outlines of the flakes. This irregular flaking off of the mineral under the blows of the hammer-stones is due to the "impure" character of the mineral, there being thread-like veins of brittle silex (?) enclosing minute pebbles extending through the mass in every direction, and these appear to have checked the flakes and caused their jagged irregular outlines.

Fig. 2 represents a remarkable javelin head made of the same material as the preceding, and having, but in a less degree, the "flame-shape" of the smaller specimen. The character of the workmanship indicates, I think, that the same aborigine chipped them both. Like the other, this spear-head is very thin and "irregularly" flaked. In the shell-heap in which these were found, as far as we have examined it, there was nothing else that differed from the ordinary "finds" and contents of aboriginal graves, being simply leaf-shaped arrow-heads, grooved stone axes, a corn-crusher and basin ("Querns," *vide* Evans' "Stone Implements of G. B.," p. 233), and a polished celt. CHAS. C. ABBOTT

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PROTECTION FOR INVENTIONS

WE stated in our leading article of the 24th ult. on this subject, that in the course of the discussion at the Society of Arts, Col. Strange had mentioned that the Patent Commissioners requested the Royal Society some time ago to nominate one of three eminent men of science who should perform the herculean task of infusing scientific order into the Patent Office, but without salary.

The Society of Arts, in their journal of the 25th ult., have very properly published correspondence which fully establishes the correctness of a statement which otherwise might well be thought incredible. The subject of niggardliness to scientific men is so important, not merely to the men themselves, but more still to the progress of knowledge, and therefore to the interests of the whole community, that we feel bound to republish this correspondence. We must, of course, regret to animadvert on the acts of the late Lord Romilly, who is no longer amongst us to justify them; but the public duty must still be performed, and as his lordship wrote as the spokesman of his colleagues, they can at any rate defend, if they can, what at present seems indefensible.

In Lord Romilly's letter the proposed duties of these unpaid men of science are enumerated: they are to "superintend the general management of the Patent Office, to see that the indexes and abstracts of the specifications are made accurate and complete, and to redress the other defects complained of."

We here see precisely what sort of work four highly salaried lawyers considered men as eminent in science as they in law might with perfect justice be expected to execute for nothing, namely, a combination of hard routine drudgery with the most delicate discrimination in questions extending over the whole range of scientific knowledge. It is true that their labours were to be lightened by the invaluable privilege of "acting in conjunction with the Lord Chancellor and the Master of the Rolls, and of referring to them" whenever the occasion of too tough a problem might require it. In plain English, the men of science were to do all the work of the Patent Office gratuitously, but in the name of these highly-paid lawyers, who notoriously do none of it, but who would thus pocket both the credit and the substantial reward.

If this had been an isolated example of the assessment of scientific work in England, we should hardly have cared to draw attention to it for the mere sake of denouncing exceptional narrowness of view and selfish injustice. It is because the example is typical that we assist Col. Strange and the Society of Arts in exposing it. The best proof of the prevalence of the same spirit is afforded us by some evidence volunteered by the Marquis of Salisbury before the Duke of Devonshire's Science Commission. His lordship observed that "Government departments have got an idea into their heads—I do not know why—that scientific opinions differ in this from medical